High-temperature superconductive conductor winding.

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US3281737
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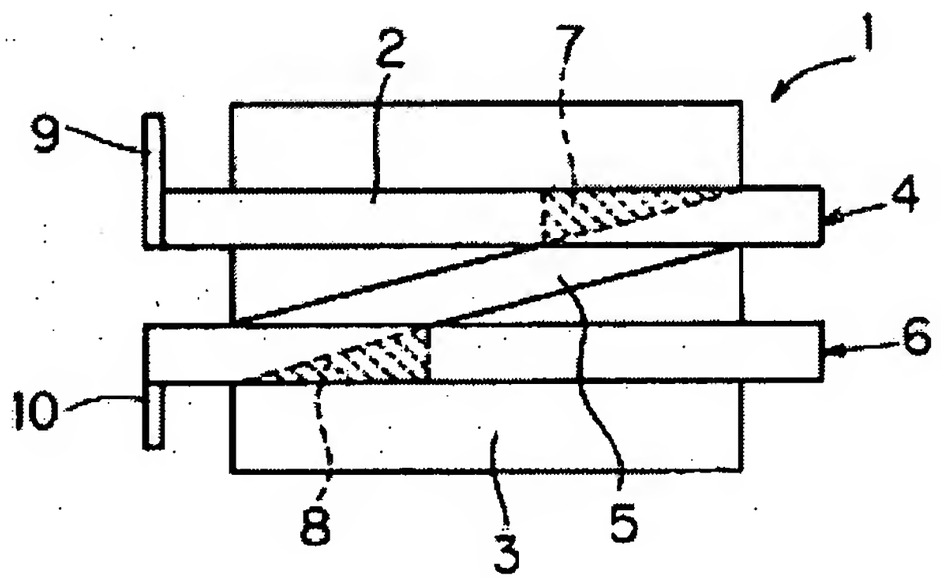
Abstract of **EP0472197**

In a high-temperature superconductive conductor winding (1) comprising a tape-type high-temperature superconducting wire (2) which is combined with a metal and wound into the form of a double pancake coil, the length of a throughout portion (5) provided between pancakes (4, 6) is at least four times the width of the tape-type high-temperature superconducting wire. Thus, it is possible to suppress generation of shearing stress at the throughout portion (5), thereby preventing reduction of the critical current density caused by such shearing stress.

FIG. 1



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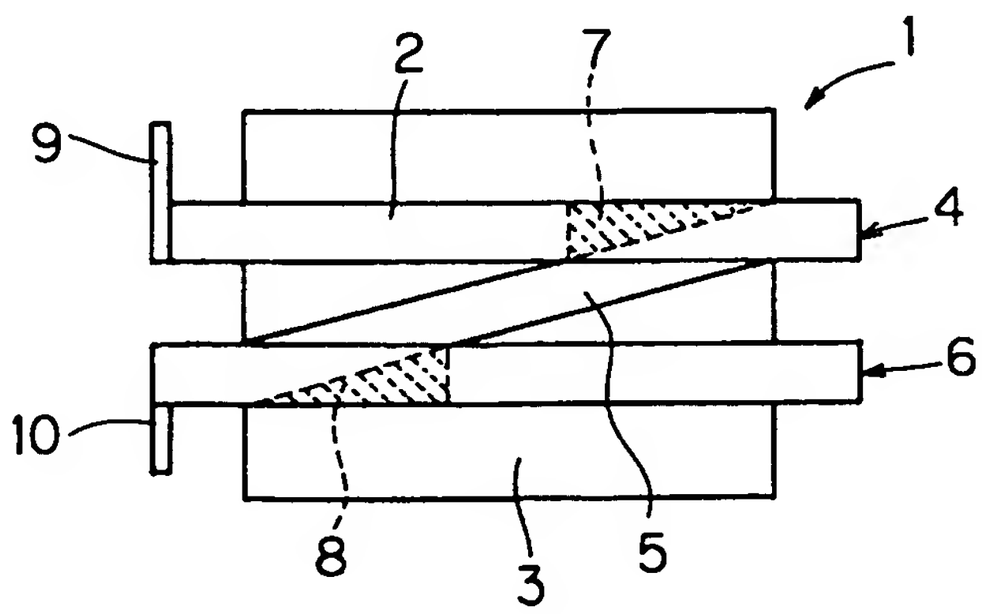
(54) High-temperature superconductive conductor winding.

(57) In a high-temperature superconductive conductor winding (1) comprising a tape-type high-temperature superconducting wire (2) which is combined with a metal and wound into the form of a double pancake coil, the length of a throughout portion (5) provided between pancakes (4, 6) is at least four times the width of the tape-type high-temperature superconducting wire. Thus, it is possible to suppress generation of shearing stress at the throughout portion (5), thereby preventing reduction of the critical current density caused by such shearing stress.

FIG. 1



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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a high-temperature superconductive conductor winding, and more specifically, it relates to improvement of properties, particularly the critical current property, of such a high-temperature superconductive conductor winding.

Description of the Background Art

A high-temperature superconductive material, which is known as a ceramic superconductor, is coated with a metal and strongly worked into a thin tape by deformation processing. It has been recognized possible to attain a high critical current density by combining such deformation processing with heat treatment.

In order to apply such a tape-type high-temperature superconducting wire to a coil, for example, it is necessary to wind the wire. In particular, such a tape-type high-temperature superconducting wire is properly wound into the form of a double pancake coil.

In such a double pancake coil, a single high-temperature wire is adapted to form two coil portions. Therefore, a throughout portion extending from one coil portion to the other coil portion is required. In relation to employment of the tape-type high-temperature superconducting wire, however, it has been recognized that the critical current density is reduced due to shearing stress which is applied to the throughout portion, since the wire is necessarily twisted at the throughout portion.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a high-temperature superconductive conductor winding obtained by winding a tape-type high-temperature superconducting wire into the form of a double pancake coil, which can suppress generation of shearing stress in a throughout portion, thereby preventing reduction of the critical current density.

The present invention is directed to a high-temperature superconductive conductor winding obtained by winding a tape-type high-temperature superconducting wire, which is combined with a metal, into the form of a double pancake coil. According to the present invention, it is noted that the length of a throughout portion is deeply concerned with the aforementioned shearing stress, as well as the critical current density.

The present invention is characterized in that the length of a throughout portion which is provided between pancakes is selected to be at least four times the width of the tape-type high-temperature superconducting wire, in order to solve the aforementioned technical problem.

In the high-temperature superconductive conductor winding according to the present invention, the high-temperature superconducting wire may be covered with an insulating material of an inorganic substance such as mica, glass fiber or quartz fiber, or an organic substance such as tetrafluoroethylene, polyimde resin or formal resin.

The inventive high-temperature superconductive conductor winding is preferably impregnated with epoxy resin. More preferably, the epoxy resin contains fiber and/or powder.

A high-temperature superconductor contained in the high-temperature superconducting wire may be divided in a multicore state.

According to the present invention, the length of the throughout portion is selected to be at least four times the width of the tape-type high-temperature superconducting wire, whereby it is possible to suppress generation of shearing stress at the throughout portion, thereby preventing reduction of the critical current density caused by such shearing stress.

According to the present invention, the high-temperature superconducting wire is preferably provided with an insulating coat, so that the same can be directly wound into a coil with no specific insulating material.

Further, the high-temperature superconductive conductor winding according to the present invention is preferably impregnated with epoxy resin, so that the winding is resistant against stress which may be applied thereto in preparation of such a winding or during excitation. More preferably, the epoxy resin contains fiber and/or powder, so that the winding is further resistant against the aforementioned stress.

The high-temperature superconductor which is contained in the high-temperature superconducting wire is preferably divided in a multicore state, so that the high-temperature superconductor is improved in strain resistance and can be wound with no problem after sintering.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevational view showing a high-temperature superconductive conductor winding 1 according to an embodiment of the present invention; and
Fig. 2 is a top plan view of the high-temperature superconductive conductor winding 1 shown in Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 1 and 2 illustrate a high-temperature superconductive conductor winding 1 according to an embodiment of the present invention. Fig. 1 is a front elevational view, and Fig. 2 is a top plan view.

This high-temperature superconductive conductor winding 1 is formed by winding a tape-type high-temperature superconducting wire 2, which is combined with a metal, on a cylindrical spool 3 into the form of a double pancake coil.

In more concrete terms, the single tape-type high-temperature superconducting wire 2 is wound on the spool 3 from its inner peripheral side to form an upper pancake, i.e., a first coil portion 4. A throughout portion 5, which is connected with the beginning end of the first coil portion 4, is guided to obliquely downwardly extend on the spool 3. The high-temperature superconducting wire 2 is then wound on the outer peripheral surface of the spool 3 from the inner peripheral side inversely to the first coil portion 4, thereby forming a lower pancake, i.e., a second coil portion 6.

In the aforementioned wound state of the tape-type high-temperature superconducting wire 2, clearances are defined along the first and second coil portions 4 and 6 due to formation of the throughout portion 5, while spacers 7 and 8 are inserted to absorb such clearances.

Current-carrying terminals 9 and 10 are mounted on both end portions of the wound high-temperature superconducting wire 2.

While the spool 3 is simply illustrated in a cylindrical configuration, flanges (not shown) are generally formed on both end portions thereof.

In this specification, the term "length of the throughout portion" indicates the length of the center line of the throughout portion 5, shown in Fig. 1, in a part exposed from the first and second coil portions 4 and 6.

Examples which were made to confirm the effect of the present invention are now described in detail.

Example 1

Oxides or carbonates containing Bi, Pb, Sr, Ca and Cu were so mixed that these elements were in composition ratios of 1.82:0.43:2.01:2.22:3.03, and this mixture was heat treated to prepare powder having a 2212 phase being composed of Bi, Pb, Sr, Ca and Cu substantially in the ratios of 2:2:1:2, and non-superconducting phases. This powder was degassed under a decompressed atmosphere of 2 Torr at 700°C for 3 hours.

The as-formed powder was filled into silver pipes. 1296 such silver pipes were charged into a large silver pipe of 12 mm in outer diameter and 10 mm in inner diameter, which in turn was drawn into an outer diameter of 1 mm and then rolled into a thickness of 0.18 mm.

The as-formed tape-type wire was heat treated at 840°C for 50 hours, and then rolled into a tape-type wire of 4 mm in width and 0.15 mm in thickness. This tape-type wire was then heat treated at 840°C for 50 hours.

This tape-type wire was coated with a formal resin film of 0.1 mm in thickness and wound on a bobbin of 15 mm in outer diameter, to prepare a double pancake coil so that each pancake had ten turns. Some samples of such double pancake coils were prepared with throughout portions of various lengths, to measure $J_{C,coil}/J_{CO}$ (critical current density in the coil form/critical current density of the wire itself).

Table 1 shows the results.

Table 1

Length of Throughout	$J_{C,coil}/J_{CO}$
2.7 x width	0.57
3.5 x width	0.74
4.3 x width	0.93
6.1 x width	0.95

It is clearly understood from Table 1 that the property of the winding was remarkably improved when the length of the throughout portion was at least four times the width of the tape-type wire.

Example 2

A tape-type wire of 4.3 mm in width and 0.14 mm in thickness was prepared in a similar manner to Example 1, and coated with a polyimide resin film in place of the formal resin film, to prepare a double pancake coil which was similar to Example 1. According to Example 2, the coil was impregnated with epoxy resin containing glass fiber.

Table 2 shows results of evaluation of the as-formed samples.

Table 2

Length of Throughout	$J_{C,coil}/J_{CO}$
2.6 x width	0.59
3.4 x width	0.77
4.5 x width	0.97
6.0 x width	0.98

It is understood from Table 2 that the effect of the present invention was further improved when the winding was impregnated with epoxy resin.

Example 3

A single-core wire was prepared through steps similar to those of Example 1. This wire was rolled into a thickness of 0.18 mm, coated with quartz fiber, and worked into a double pancake coil, which was heat treated at 840 ° C for 50 hours.

Also in this case, the coil exhibited an excellent critical current density exceeding 90 % of that of the wire itself when the length of the throughout portion was set to be at least four times the width of the wire.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the scope of the present invention being limited only by the terms of the appended claims.

Claims

1. A high-temperature superconductive conductor winding comprising a tape-type high-temperature superconducting wire being combined with a metal and wound into the form of a double pancake coil, wherein

   the length of a throughout portion provided between pancakes is at least four times the width of said tape-type high-temperature superconducting wire.

2. A high-temperature superconductive conductor winding in accordance with claim 1, wherein said high-temperature superconducting wire is provided with an insulating coat.

3. A high-temperature superconductive conductor winding in accordance with claim 1, wherein said winding is impregnated with epoxy resin.

4. A high-temperature superconductive conductor winding in accordance with claim 3, wherein said epoxy resin contains fiber and/or powder.

5. A high-temperature superconductive conductor winding in accordance with claim 1, wherein a high-temperature superconductor contained in said high-temperature superconducting wire is divided in a multicore state.

FIG. 1

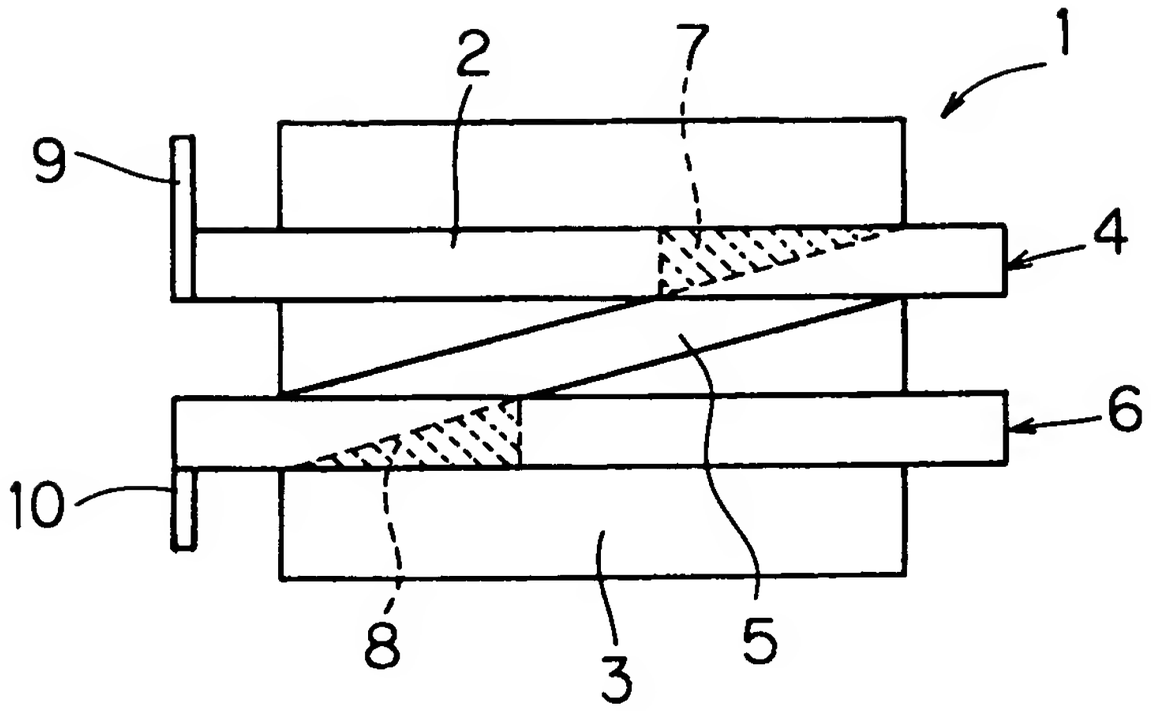
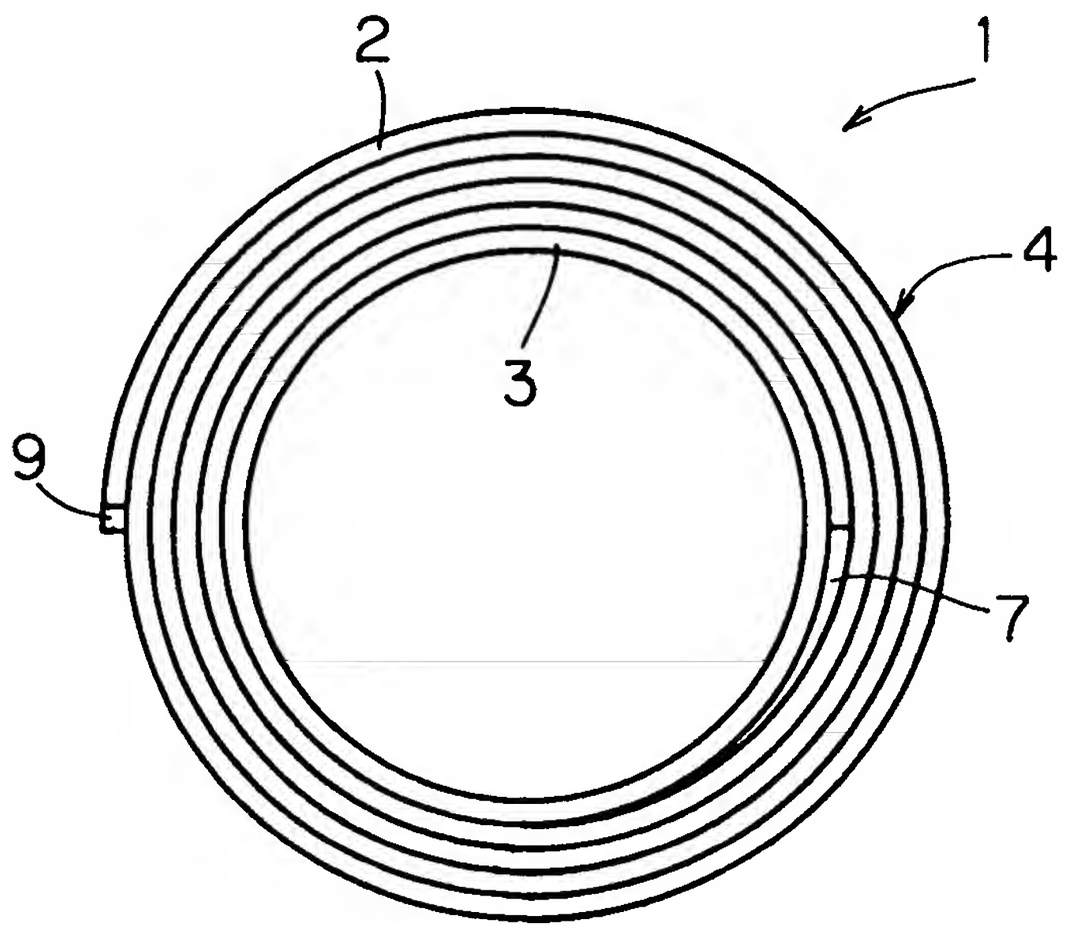


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number EP 91114090.3

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US - A - 3 281 737 (SWARTZ) * Claims 1-15; fig. 3,12 * --	1-5	H 01 F 7/22
A	US - A - 3 813 764 (TANAKA) * Abstract; Fig. 1 * --	1-5	
A	EP - A - 0 045 604 (MITSUBISHI) * Abstract; Fig. 2,6;claims 1-3 * --	1-5	
A	US - A - 4 499 443 (MATERNA) * Abstract; claims 1-18; fig. 1 * ----	1-5	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5) H 01 F 7/00 H 01 F 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-11-1991	VAKIL

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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